

<https://helda.helsinki.fi>

Proximate and Sensory Analysis of Wheat Bread Supplemented with Onion Powder and Onion Peel Extract

Masood, Sara

2020

Masood , S , Rehman , A U , Bashir , S , Imran , M , Khalil , P , Khursheed , T , Iftikhar , F , Jaffar , H M , Farooq , S , Rizwan , B & Javaid , N 2020 , ' Proximate and Sensory Analysis of Wheat Bread Supplemented with Onion Powder and Onion Peel Extract ' , Bioscience research , vol. 17 , no. 4 , pp. 4071-4078 .

<http://hdl.handle.net/10138/327491>

cc_by
publishedVersion

Downloaded from Helda, University of Helsinki institutional repository.

This is an electronic reprint of the original article.

This reprint may differ from the original in pagination and typographic detail.

Please cite the original version.



Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network



RESEARCH ARTICLE

BIOSCIENCE RESEARCH, 2020 17(4): 4071-4078.

OPEN ACCESS

Proximate and Sensory Analysis of Wheat Bread Supplemented with Onion Powder and Onion Peel Extract

Sara Masood ^{1*}, Attiq ur Rehman ^{2,3}, Shahid Bashir ¹, Muhammad Imran ¹, Palwasha Khalil ¹, Tara Khursheed ¹, Faiza Iftikhar ¹, Hafiza Madiha Jaffar ¹, Sana Farooq ¹, Bahisht Rizwan ¹ and Nida Javaid ¹

¹ University Institute of Diet and Nutritional Sciences (UIDNS), Faculty of Allied Health Sciences, The University of Lahore, Lahore, **Pakistan**

² Department of Agricultural Sciences, Faculty of Agriculture and Forestry, The University of Helsinki, FI-00790 Helsinki, **Finland**

³ Natural Resources Institute (Luke), Horticulture Technologies, Production Systems Unit, Toivonlinnantie 518, FI-21500 Piikkiö, **Finland**

*Correspondence: sarah.13494@gmail.com Received 09-10-2020, Revised: 10-12-2020, Accepted: 20-12-2020 e-Published: 27-12-2020

In current era, the agro-waste production is tremendously increasing which strongly influences the stability of the ecosystem and ultimately the human health. Onion is among one of the most commonly consumed vegetables worldwide, but its peel is generally regarded as waste, which is rich in various phytonutrients. Wheat bread is consumed as a staple food by large number of populations hence this study was aimed at improving the nutritional quality of bread by supplementing it with onion peel extract (OPE) and onion powder (OP). A control bread was synthesized using standard formulation while breads supplemented with OPE and OP were prepared by substituting wheat flour with OPE and OP at 1%, 3% and 5%, 7% respectively. Proximate analysis of five types of bread (A, B, C, D, E) presented that addition of onion peel extract significantly ($p < 0.05$) improved the moisture content (21.06-21.79%) of breads while incorporation of onion powder brought significant improvement in fiber (0.24-0.32%), protein (9.80-10.35%) and ash content (1.55-1.94%). Sensory analysis of the breads was done by a semi-trained panel constituting of 7 members. Significant differences were reported among the five treatments for appearance, texture, taste, odor and overall acceptability. Maximum score for all the above-mentioned attributes was obtained by 1% OPE fortified bread while the 7% onion powder fortified bread attained the lowest scores. The sensory attributes of OPE makes it a good flavoring ingredient for baked items.

Keywords: onion peel extract (OPE), onion powder (OP), sensory evaluation, proximate analysis, wheat bread

INTRODUCTION

Onion (*Allium cepa* L.) is among the initially cultivated crops of the world probably due to its greater shelf life and portability. It is common item of the daily diet of most populations and has got great economic importance throughout the world. Onion has been evaluated as an excellent source

of flavonoids polyphenols and sulphur containing compounds and dietary fiber (Lachman et al. 2018) (Takahashi and Shibamoto 2008). Moreover, it also contributes in the maintenance and regulation of body functions due to presence of carbohydrates, essential vitamins and minerals (Bhattacharjee 2013).

Wheat (*Triticum aestivum*. L) is among one of the most commonly consumed grains and it can contribute to more than 50% of the total caloric intake worldwide. Also, cereals are relatively low-priced as compared to other food commodities and are cultivated and utilized all around the world by people belonging from all economic classes. The pro-health benefits of whole grains are associated with the presence of high percentage of polyphenols and fiber that are important in preventing risk of degenerative diseases in which oxidative stress is involved (Świeca et al. 2012) (Lim et al. 2011). Unfortunately, most of the fiber and bioactive constituents found in the grains are predominantly present in the bran and aleurone layer (Anson et al. 2011). Among the various ingredients that could be added during bread formulation are certain herbs and spices that can promptly improve its nutraceutical potential (Balestra et al. 2011). Currently, food processing industries generate considerable amount of biological waste such as peels and seeds that are rich sources of antioxidants and can be added as ingredients in various food commodities (Anson et al. 2011), (Roldán et al. 2008), (Carvalho et al. 2013).

Onion is one of the most commonly used vegetables in most cuisines and hence got great economic importance worldwide (Griffiths et al. 2002), (Jakubowski 2003). All the varieties of onion have shown to have good content of flavonoids specifically quercetin and its derivatives. Quercetin has excellent antioxidant potential and can play a role in scavenging free radicals, chelating metals along with inhibiting lipid peroxidation and hence can prevent the development of certain chronic diseases (Boots et al. 2011), (Gawlik-Dziki et al. 2011). Previously, Bhattacharjee did proximate analysis of onion varieties and reported that onion bulb contain 82.77% of moisture, 0.24% of crude ash, 1.48% of crude protein, 0.72% of crude fat, 1.65% of crude fiber and 14.77 % of nitrogen free extract (Bhattacharjee 2013). While Ugwoke determined that the concentration of carbohydrate, protein, fat and fiber in onion bulb is 73.36%, 11.53%, 0.97% and 0.07%, respectively (Ugwoke and Ezugwe 2011). Nutritional composition of onion powder or onion peel supplemented breads hasn't been evaluated yet. Hence one purpose of the study is to determine the proximate composition of onion supplemented breads for a possible human consumption based on organoleptic acceptance.

The instrumental measurements such as texture profile analysis (TPA) can give an insight

on the possible perception of the consumers about a particular product, but it was stated that consumer's preference does not depend only on the texture characteristics of the food product. Certain characteristics such as flavor, aroma and taste cannot be assessed instrumentally and hence complete sensory profile of a product is of immense importance (Kihlberg et al. 2004), (Arshad, Anjum, and Zahoor 2007). The practical application of sensory evaluation techniques is an excellent tool for baking industry as it helps in the delivery of a quality assured product which is elaborated in understandable terms for the buyers. Sensory analysis is believed to be an effective method of food characterization on the basis of organoleptic and aesthetic parameters (Elortondo et al. 2007). Hedonic scales are frequently used to ascertain the preference and acceptability of a food product sensed by a group of panelists (Sidel and Stone 1993). In the current study we investigated the differences between three types of supplemented wheat breads on the basis of organoleptic as well as aesthetic properties by a group of semi-trained panelist. A sensory evaluation has been done by using a hedonic scale to identify the most suitable and acceptable type of bread for consumer use.

MATERIALS AND METHODS

Preparation of Onion Powder

Onions were purchased from a local market. The outer dry layers were peeled off manually by using a sterile knife. The obtained onion peels were kept in a separate jar for extraction while the bulbs were chopped further and dried by placing them in the drying oven at 50 °C over a period of 3 days. The dried onions were then grinded into fine powder (using electric grinder) that was then kept in an airtight jar inside the refrigerator.

Preparation of Onion peel extract

The onion dry peels were washed thoroughly with sterile water and then were kept in the drying oven at 50 °C for 3 days. The obtained peels were then extracted with 60% ethanol, maintained to pH 5.5 at 50°C for a period of 3 hours. The extract was then kept in an airtight test tube and stored in refrigerator prior to use.

Bread making

Five types of breads were made; a control bread without any supplementation (Bread A), bread with 1% onion peel extract (Bread B), bread with 3% onion peel extract (Bread C), bread with

5% onion powder (Bread D), bread with 7% onion powder (Bread E).

Table 1: Composition of various bread samples used in the study.

Bread/Sample code	Onion powder %	Onion peel extract %	Wheat flour (g)	Yeast (g)	Margarine (g)	Salt (g)	Sugar (g)	Water (ml)
A (Control)	0	0	100	2.0	10	1.0	12	60
B (OPE_1)	0	1	99	2.0	10	1.0	12	60
C (OPE_3)	0	3	97	2.0	10	1.0	12	60
D (OP_5)	5	0	95	2.0	10	1.0	12	60
E (OP_7)	7	0	93	2.0	10	1.0	12	60

Preparation of each type of bread was done by following same steps and the composition is presented in Table 1. Refined wheat flour was used for each kind of bread formulations. For bread B and C, substitution of onion peel extract was done by 1% and 3% respectively while for bread D and E substitution of onion powder was done at 5% and 7% respectively. Water, salt, yeast, sugar and margarine were added to each bread formulation to make respective dough(s). All the ingredients were added in the bowl of a spiral mixer and dough was kneaded for a duration of 20 minutes which was later kept for fermentation at 25°C for duration of 90 minutes. Small batches of dough (300gm) were baked in preheated oven at 180 °C for 35 minutes and then kept to cool down for 24 hours at room temperature.

Analytical methods

Proximate analysis

Moisture, ash, fat, crude protein, crude fiber and carbohydrate content of the bread samples fortified with onion peel extract or onion powder and 100% wheat bread (control) were evaluated by following the standard analytical method. All the mentioned parameters were assessed by using (Association of Official Analysis Chemists International (AOAC) 2000) while the carbohydrate percentage was determined by following the arithmetic difference method (i.e. 100 -% Protein, % Moisture, % Fiber, % Fat, % Ash).

Mineral content

For assessment of mineral content, 5 g of bread samples was ashed, and the concentration of minerals (potassium, calcium, phosphorus, zinc and iron) was assessed by using Atomic Absorption spectrophotometer (AAS).

Sensory evaluation

Screening of participants

Participants were screened before they were included in the sensory panel by using a questionnaire along with a practical test in which participants were requested to recognize the five basic tastes. An inclusion criterion was specified as:

- 1-Likelihood for the type of product.
- 2-Participant does consume the product on regular basis.
- 3-Participant could distinguish among five basic tastes; sweet, bitter, sour, salty, umami and could recognize a neutral sample.
- 4-Finally, 7 participants were included in the panel of sensory evaluation.

Training of Panel

Participants were invited to the test approximately one week prior to the session. The invitations did contain instructions that had to be followed before the test i.e.

- 1-Try not to smoke, consume coffee or spicy food close to the test session.
- 2-Try not to wear strong scented perfumes or hairsprays.
- 3-Try not to be too full or too hungry at the test session.
- 4-Rinse mouth with plain water before and after testing each sample.

Experimental Design and Statistical Analysis

Mean and standard deviation values have been computed from all the scores for each attribute of all five bread formulations. Analysis of Variance (ANOVA) have been computed ($\alpha = 0.05$) for a Completely Randomized Design (CRD) to compare mean values for each attribute as well as overall acceptability. A Tukey-Kramer HSD test have been executed (at $\alpha = 0.05$) to get pairwise comparisons for all five bread types. All the statistical measures were computed by SPSS (Version 25.0).

RESULTS

In onion peel extract fortified breads, the moisture content increases (21.06 – 21.79%) as the substitution percentage of onion peel extract is increased. Moreover, the content of fiber in onion powder bread increased significantly ($p < 0.05$) with the increase in proportion of onion powder inside the flour blends. Breads in which 7% onion powder was fortified had the highest (0.32%) fiber content while the control (un-fortified) bread had the lowest content of fiber (0.093 %).

The protein content of the onion powder fortified breads samples was also more (9.80–10.35%) as compared to control bread samples (8.72%) and it was in correspondence with the increasing percentage of the onion powder.

Increase in percentage of ash content was observed in onion powder and onion peel extract fortified bread samples while 7% onion powder supplemented breads had the highest ash content (1.94%) as compared to others (Table 2).

Mineral content of the onion powder and onion peel fortified breads

It has been observed that the overall mineral contents of the onion powder and onion peel extract supplemented bread increases with the raise in the fortificant substitution percentage in

the flour blend, but exception is observed in the case of iron whose concentration level decrease (10.73%) as the fraction of onion powder increases in the bread (Table 3).

Sensory evaluation of control and onion supplemented breads

All the computed means as well as standard deviation is presented in Table 4 on the basis of appearance, taste, texture, odour and overall acceptability for all five bread formulations. Bread supplemented with 1% onion peel extract showed highest mean value for taste (8.71 ± 0.48) whereas the bread supplemented with 7% onion powder has shown the lowest mean value (4.42 ± 0.53) in terms of overall acceptability. On the other hand, bread types fortified with 3% onion peel extract and 5% onion peel showed intermediate scores.

Statistically significant differences among five different types of supplemented breads provide the basis for consumer preference. The 1% onion peel supplemented bread scored the highest mean for overall acceptability (9.00 ± 0.00), followed by the 3% onion peel extract supplemented bread (7.57 ± 0.78) while 7% Onion powder supplemented bread had the lowest score (4.42 ± 0.78). Moreover, mean comparison for all evaluation attributes clearly indicate that bread B is being preferred over A, C, D and E (Table 4).

Table 2: Moisture, ash, crude protein, crude fat, crude fiber, and NFE in five different types of breads used in the study

Bread type	Moisture%	Protein%	Fat%	Fiber%	Ash%	NFE%
A (Control)	20.09 \pm 0.30	8.72 \pm 0.05	7.65 \pm 0.23	0.093 \pm 0.005	0.73 \pm 0.020*	62.33 \pm 0.30
B (OPE_1)	21.06 \pm 0.24*	8.87 \pm 0.04	7.64 \pm 0.02	0.083 \pm 0.005	0.93 \pm 0.02*	61.38 \pm 0.19
C (OPE_3)	21.79 \pm 0.049*	9.02 \pm 0.07*	7.65 \pm 0.02	0.086 \pm 0.005	0.98 \pm 0.02*	60.46 \pm 0.09
D (OP_5)	20.03 \pm 0.24	9.80 \pm 0.10*	7.46 \pm 0.037	0.24 \pm 0.02*	1.55 \pm 0.01*	60.89 \pm 0.38
E (OP_7)	19.78 \pm 0.17	10.35 \pm 0.02*	7.50 \pm 0.03	0.32 \pm 0.02*	1.94 \pm 0.02*	60.09 \pm 0.19

Values presented as Mean \pm SD. * shows significance at 0.05

Table 3: Phosphorus, Potassium, Calcium, Zinc and Iron content in five different types of breads used in the study

Bread type	Phosphorus	Potassium	Calcium	Zinc	Iron
A (Control)	15.16 \pm 0.05	227.06 \pm 0.25	316.13 \pm 0.20	0.47 \pm 0.01	12.20 \pm 0.17
B (OPE_1)	15.88 \pm 0.01*	228.50 \pm 0.10*	318.53 \pm 0.40*	0.49 \pm 0.05	12.13 \pm 0.05
C (OPE_3)	16.70 \pm 0.10*	230.14 \pm 0.07*	319.23 \pm 0.05*	0.51 \pm 0.01*	12.20 \pm 0.10
D (OP_5)	18.00 \pm 0.17*	234.25 \pm 0.13*	326.13 \pm 0.55*	0.63 \pm 0.01*	11.23 \pm 0.05*
E (OP_7)	18.53 \pm 0.15*	235.52 \pm 0.07*	330.90 \pm 0.30*	0.82 \pm 0.01*	10.73 \pm 0.15*

Values presented as Mean \pm SD. * shows significance at 0.05

Table 4: Mean and respective standard deviation values of four individual attributes and overall acceptability of each type of bread formulation evaluated on a hedonic scale (1-9)

Bread type	Appearance	Taste	Texture	Odour	Overall acceptability
A (Control)	6.42 ± 0.78	6.28 ± 0.48	7.14 ± 0.37	7.57 ± 0.53	6.57 ± 0.53
B (OPE_1)	8.0 ± 0.81	8.71 ± 0.48	8.85 ± 0.37	8.71 ± 0.48	9.00 ± 0.00
C (OPE_3)	7.42 ± 0.78	8.14 ± 0.89	8.57 ± 0.53	8.00 ± 0.57	7.57 ± 0.78
D (OP_5)	6.71 ± 0.75	6.14 ± 0.89	5.42 ± 0.53	5.71 ± 0.75	5.57 ± 0.53
E (OP_7)	5.57 ± 0.78	4.42 ± 0.53	5.28 ± 1.11	4.71 ± 0.75	4.42 ± 0.78

Values presented as Mean ± SD.

DISCUSSION

Moisture content

The moisture content of wheat breads supplemented with onion powder was fairly low (19.78-20.03%) as compared to the breads supplemented with onion peel extract (21.06-21.79%) (Table 2) which indicates that fortification of breads with higher proportions (5-7%) of onion powder will reduce its softness as compared to the extract which has rather opposite effect. But, the shelf life of onion powder supplemented breads would have increased than the rest of the breads in regard to their low moisture content.

Previous studies have reported that chemical composition of the fortificant influences the overall moisture content. The moisture content of the onion peel extract supplemented breads (21.06-21.79%) differs by smaller percentage with moisture content of pullan fortified breads (20.83%) (NithyaBalaSundari et al. 2020), but it was fairly less as compared to the moisture content of wheat bread supplemented with vine tea extract (39.40–40.16%) reported by (Ma et al. 2020).

Protein content

In onion powder fortified breads, the raise in protein content might be due to presence of bioavailable aminoacids in the onion bulb. The edible portion of onion has been reported to contain significant amount of protein as mentioned by (IFESAN 2017).

The results indicated that protein content (10.3–13.5%) of onion powder supplemented bread is close with buckwheat flour fortified bread (11-16%) (Mohajan et al. 2019), but considerably lower than the potato based breads that were fortified with whole soy flour (30–70%) (Gomes Natal et al. 2013). The variation in protein content of fortificants might be responsible for this change.

Ash content

The mineral content of food samples can be assessed by determining ash content. The raise in ash content of onion powder fortified bread might be due to the considerably higher content of minerals present in onion. (Bhattacharjee S). The ash content of onion powder supplemented breads (1.55-1.94) is higher than Gluten-free Flat Bread that was made from Marinduque Arrowroot in which the ash content was (0.47%) (Edelwina and Blase 2017)

Fat content

No significant differences have been observed in fat content of control bread and onion peel extract and onion powder fortified breads (Table 2) which highlights towards considerably low percentage of fat that is present in onion bulb and peel.(IFESAN 2017) (Bhattacharjee 2013)

Crude fiber content

Bread samples that were supplemented with onion powder the crude fiber content (0.24–0.32%) was increased significantly ($p < 0.05$) and this might be due to various fructooligosaccharides that are found in onion (Pöhnl et al. 2017). In unfortified wheat breads the crude fiber content was 0.093%.

Carbohydrate content

The decrease in carbohydrate content (60.09-61.38%) was observed in onion peel and powder supplemented breads as compared to control bread. The carbohydrate content was highest in control bread while it was lowest in 7% onion powder fortified bread. Similar kind of findings were obtained from a study in which carbohydrate content was reduced after incorporation of watermelon seed flour (Anang et al. 2018)

Mineral content of OPE and OP fortified breads

The considerably high concentration of

mineral content in the bulb and peel of onion might be responsible for the raised level of minerals in the fortified bread samples as compared to the un-fortified bread. It has been reported that both edible portion and skin of onion is rich in calcium, phosphorus, zinc, potassium, sodium and manganese. All these minerals play a very vital role in growth and development of individual. Low level of iron has been recorded in fortified breads as compared to the control bread (Table 3) and this might be due to the low concentration of iron in onion.

In wheat bread fortified with 7% onion powder, the calcium concentration is fairly higher than that of the bread fortified with whole green banana flour (Khoozani et al. 2020)

Both phosphorus and potassium serve as important minerals that are integral constituents of cell and body fluids and are also involved in regulation of blood pressure and heart functions. Wheat cookies that were supplemented with orange-fleshed sweet potato had higher potassium content than the wheat bread supplemented with onion bulb powder (Kolawole, Akinwande, and Ade-Omowaye 2020). Similarly, the zinc content of the onion powder fortified bread was higher than un-fortified bread.

Sensory attributes of OPE and OP fortified bread

Findings of the sensory evaluation proposed that samples of bread that were fortified with 1% onion peel extract was more liked and preferred by the panelist as compared to the onion powder supplemented breads and control bread. Un-fortified breads and breads supplemented with 3% onion peel extract were rated alike in most of the attributes that were assessed (Table 4).

However, it is important to note that the unique flavor of the onion powder supplemented bread was considered objectionable by panelists particularly in higher percentage. The primary functional compounds in onion skin includes quercetin aglycone, allyl sulphur compounds, quercetin 4-glucoside and small percentage of isorhamnetin or kaempferol is also present (Wiczowski et al. 2008), (Corzo-Martínez, Corzo, and Villamiel 2007). The presence of functional constituents like quercetin and allyl sulfur compounds make onion peel and onion powder supplemented breads more nutritious as compared to plain bread. Moreover, it should be emphasized that some previous studies in which flavonoids content of onion were isolated with organic solvents have reported that quercetin

extraction with 90% ethanol can enrich the final extracts to almost 15 times as compared to the buffer extraction (Jung et al. 2011). An interesting observation from this study is that the values for organoleptic traits like aroma, appearance, texture and taste of onion peel extract supplemented breads were also proved to be superior as compared to plain white flour bread. Therefore, there is a potential to testify the use of onion peel in other types and forms of breads to drive the idea of food supplementation parallel to food innovation. We hypothesize a big margin of sustainable use of onion peel in other food products too, which need proper experimentation and sensory evaluations. A significant gap of scientific inquiries exists to unravel the potential use of onion peel and related food waste in our daily diets. Bio-chemical as well as nutraceutical studies of onion peel extract would help to better understand and implement food waste management in a healthy and sustainable way. Detailed studies and investigations are recommended to the scientific community working in relevant areas of field.

CONCLUSION

Supplementing breads with onion powder and onion peel extract improved the overall proximate and mineral contents of the fortified bread. Onion peel supplemented bread had better overall acceptability scores than the other bread types. Instruments don't have the sensitivity of human sensory systems. They can hardly compare with the mechanical interpretation of foods when tasted orally. Only human sensory evaluation can provide the most specific model that can interpret how the consumers are going to perceive a food product in real life. Onion bulb along with its skin contains high percentage of phytonutrients and breads supplemented with these seems to be good sources of carbohydrates, proteins, fats, minerals and fiber. Previous researches have shown that outer dry peel of onion contains significantly greater levels of flavonoids as compared to the edible portion of vegetable. Also, as peel is a waste material that comes from food industry hence, it's incorporation as a functional supplement in bread can be a great strategy. As bread is among one of the most commonly consumed commodities around the globe hence it is an effective target for food supplementation. However, further research must be done on the phytochemical content and the disease preventive effects of such onion supplemented breads. Enlightening public about the nutritional benefits

of the onion supplemented functional foods could be helpful in improving the sensory acceptability of onion incorporated breads.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEDGEMENT

We acknowledge Dr. Aurang Zeb from UIDNS, UoL, Lahore-Pakistan for continuous support and guidance throughout the study.

AUTHOR CONTRIBUTIONS

SM, AR, SB, and MI designed the study. SM, PK, TK, FI, HMJ, SF, BR, and NJ performed the experiments and collected data. AR analyzed the data. SM and AR wrote the manuscript. AR reviewed the manuscript. All authors read and approved the final version.

Copyrights: © 2020@ author (s).

This is an open access article distributed under the terms of the [Creative Commons Attribution License \(CC BY 4.0\)](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

REFERENCES

- Anang, Daniel A., Ruth A. Pobee, Edward Antwi, Eugene M. Obeng, Amy Atter, Foster K. Ayittey, and John T. Boateng. 2018. "Nutritional, Microbial and Sensory Attributes of Bread Fortified with Defatted Watermelon Seed Flour." *International Journal of Food Science and Technology*.
- Anson, Nuria Mateo, Anna Marja Aura, Emilia Selinheimo, Ismo Mattila, Kaisa Poutanen, Robin Van Den Berg, Robert Havenaar, Aalt Bast, and Guido R. M. M. Haenen. 2011. "Bioprocessing of Wheat Bran in Whole Wheat Bread Increases the Bioavailability of Phenolic Acids in Men and Exerts Antiinflammatory Effects Ex Vivo1-3." *Journal of Nutrition*.
- Arshad, Muhammad Umair, Faqir Muhammad Anjum, and Tahir Zahoor. 2007. "Nutritional Assessment of Cookies Supplemented with Defatted Wheat Germ." *Food Chemistry*.
- Association of Official Analysis Chemists International (AOAC). 2000. *Official Methods of Analysis of AOAC International*.
- Balestra, Federica, Emiliano Cocci, Gian Gaetano Pinnavaia, and Santina Romani. 2011. "Evaluation of Antioxidant, Rheological and Sensorial Properties of Wheat Flour Dough and Bread Containing Ginger Powder." *LWT - Food Science and Technology*.
- Bhattacharjee, Shovon. 2013. "Analysis of the Proximate Composition and Energy Values of Two Varieties of Onion (*Allium Cepa* L.) Bulbs of Different Origin: A Comparative Study." *International Journal of Nutrition and Food Sciences*.
- Boots, Agnes W., Marjolein Drent, Vincent C. J. de Boer, Aalt Bast, and Guido R. M. M. Haenen. 2011. "Quercetin Reduces Markers of Oxidative Stress and Inflammation in Sarcoidosis." *Clinical Nutrition*.
- Carvalho, Ana Flávia Azevedo, Pedro de Oliva Neto, Douglas Fernandes da Silva, and Gláucia Maria Pastore. 2013. "Xylo-Oligosaccharides from Lignocellulosic Materials: Chemical Structure, Health Benefits and Production by Chemical and Enzymatic Hydrolysis." *Food Research International*.
- Corzo-Martínez, Marta, Nieves Corzo, and Mar Villamiel. 2007. "Biological Properties of Onions and Garlic." *Trends in Food Science and Technology*.
- Edelwina, Ma and M. Blase. 2017. "Sensory Attributes and Proximate Analysis of Sinalab: A Traditional Gluten-Free Flat Bread of Marinduque from Arrowroot (*Maranta Arundinacea* Linn)." *International Journal of Advances in Agricultural Science and Technology*.
- Elortondo, F. J. Pére., M. Ojeda, M. Albisu, J. Salmerón, I. Etayo, and M. Molina. 2007. "Food Quality Certification: An Approach for the Development of Accredited Sensory Evaluation Methods." *Food Quality and Preference*.
- Gawlik-Dziki, Urszula, Michał Świeca, Danuta Sugier, and Joanna Cichocka. 2011. "Comparison of in Vitro Lipoxigenase, Xanthine Oxidase Inhibitory and Antioxidant Activity of Arnica Montana and Arnica Chamissonis Tinctures." *Acta Scientiarum Polonorum, Hortorum Cultus*.
- Gomes Natal, Dorina Isabel, Maria Inés de Souza Dantas, Márcia Cristina Teixeira Ribeiro Vidigal, Sônia Machado Rocha Ribeiro, Roberta Ribeiro Silva, and Hércia Stampini

- Duarte Martino. 2013. "Physical and Sensorial Properties of Potato Breads Fortified with Whole Soybean Flour." *Revista Chilena de Nutrición*.
- Griffiths, Gareth, Laurence Trueman, Timothy Crowther, Brian Thomas, and Brian Smith. 2002. "Onions - A Global Benefit to Health." *Phytotherapy Research*.
- IFESAN, Beatrice O. T. 2017. "Chemical Composition of Onion Peel (*Allium Cepa*) and Its Ability to Serve as a Preservative in Cooked Beef." *International Journal of Science and Research Methodology* 7(4):25–34.
- Jakubowski, Hieronim. 2003. "On the Health Benefits of Allium Sp." *Nutrition*.
- Jung, Ji Young, Yeni Lim, Min Sun Moon, Ji Yeon Kim, and Oran Kwon. 2011. "Onion Peel Extracts Ameliorate Hyperglycemia and Insulin Resistance in High Fat Diet/Streptozotocin-Induced Diabetic Rats." *Nutrition and Metabolism* 8:1–8.
- Khoozani, Amir Amini, Biniam Kebede, John Birch, and Alaa El-Din Ahmed Bekhit. 2020. "The Effect of Bread Fortification with Whole Green Banana Flour on Its Physicochemical, Nutritional and in Vitro Digestibility." *Foods*.
- Kihlberg, Iwona, Lisbeth Johansson, Achim Kohler, and Einar Risvik. 2004. "Sensory Qualities of Whole Wheat Pan Bread - Influence of Farming System, Milling and Baking Technique." *Journal of Cereal Science*.
- Kolawole, Fausat L., Bolanle A. Akinwande, and Beatrice I. O. Ade-Omowaye. 2020. "Physicochemical Properties of Novel Cookies Produced from Orange-Fleshed Sweet Potato Cookies Enriched with Sclerotium of Edible Mushroom (*Pleurotus Tuberregium*)." *Journal of the Saudi Society of Agricultural Sciences*.
- Lachman, J., D. Proněk, A. Hejtmánková, J. Dudjak, V. Pivec, and K. Faitová. 2018. "Total Polyphenol and Main Flavonoid Antioxidants in Different Onion (*Allium Cepa* L.) Varieties." *Horticultural Science*.
- Lim, Ho S., So H. Park, Kashif Ghafoor, Sung Y. Hwang, and Jiyong Park. 2011. "Quality and Antioxidant Properties of Bread Containing Turmeric (*Curcuma Longa* L.) Cultivated in South Korea." *Food Chemistry*.
- Ma, Qian, Shengbao Cai, Yijia Jia, Xiyan Sun, Junjie Yi, and Jiang Du. 2020. "Effects of Hot-Water Extract from Vine Tea (*Ampelopsis Grossedentata*) on Acrylamide Formation, Quality and Consumer Acceptability of Bread." *Foods*.
- Mohajan, S., MM Munna, TN Orchy, MM Hoque, and T. Farzana. 2019. "Buckwheat Flour Fortified Bread." *Bangladesh Journal of Scientific and Industrial Research*.
- NithyaBalaSundari, S., V. Nivedita, M. Chakravarthy, G. Srisowmeya, Usha Antony, and G. Nandhini Dev. 2020. "Characterization of Microbial Polysaccharides and Prebiotic Enrichment of Wheat Bread with Pullulan." *LWT*.
- Pöhl, Tobias, Christoph Böttcher, Hartwig Schulz, Melanie Stürtz, Sabine Widder, Reinhold Carle, and Ralf M. Schweiggert. 2017. "Comparison of High Performance Anion Exchange Chromatography with Pulsed Amperometric Detection (HPAEC-PAD) and Ultra-High Performance Liquid Chromatography with Evaporative Light Scattering (UHPLC-ELSD) for the Analyses of Fructooligosaccharides in Onion." *Journal of Food Composition and Analysis*.
- Roldán, Eduvigis, Concepción Sánchez-Moreno, Begoña de Ancos, and M. Pilar Cano. 2008. "Characterisation of Onion (*Allium Cepa* L.) by-Products as Food Ingredients with Antioxidant and Antibrowning Properties." *Food Chemistry*.
- Sidel, Joel L. and Herbert Stone. 1993. "The Role of Sensory Evaluation in the Food Industry." *Food Quality and Preference*.
- Świeca, Michał, Urszula Gawlik-Dziki, Dariusz Kowalczyk, and Urszula Złotek. 2012. "Impact of Germination Time and Type of Illumination on the Antioxidant Compounds and Antioxidant Capacity of Lens Culinaris Sprouts." *Scientia Horticulturae*.
- Takahashi, Mizuho and Takayuki Shibamoto. 2008. "Chemical Compositions and Antioxidant/Anti-Inflammatory Activities of Steam Distillate from Freeze-Dried Onion (*Allium Cepa* L.) Sprout." *Journal of Agricultural and Food Chemistry*.
- Ugwoke, CEC and CO Ezugwe. 2011. "Phytochemical Screening and Proximate Composition and Onion Bulb (*Allium Cepa* L.)" *Journal of Pharmaceutical and Allied Sciences*.
- Wiczowski, Wiesław, Jerzy Romaszko, Adam Bucinski, Dorota Szawara-Nowak, Joanna Honke, Henryk Zielinski, and Mariusz K. Piskula. 2008. "Quercetin from Shallots (*Allium Cepa* L. Var. *Aggregatum*) Is More Bioavailable than Its Glucosides." *Journal of Nutrition*.